D R A F T S Y L L A B U S
Psychology 681, Perceptual Organization
Spring, 2014
Thurs, 2:30 - 5:30 p.m.
Sewall Hall 462, Rice University
CRN 22299

Instructor: Dr. James R. Pomerantz
Hours: Tues 2:30 – 3:30 pm or by appointment

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Brief Description (for a detailed description, see the end of this syllabus):
This will be an advanced graduate course dealing with perceptual organization in vision but in other senses and cognitive domains as well. We examine the theoretical issues underlying perceptual organization; the principal phenomena (including grouping, the perception of parts versus holes; figure ground segregation; multistability). We will examine the methods used to reveal the perception of structure; the neural basis of perceptual organization; the integration of parts into wholes, including multisensory integration; theories of perceptual organization; and the key problems remaining to be resolved in the field. Remaining topics will be tailored toward the interests and backgrounds of the students enrolled.
Prerequisites: PSYC 581 or permission of instructor.

Primary Text:
J. Wagemans (Ed.), *Oxford Handbook of Perceptual Organization*. Oxford University Press, in press. Expected to appear 2014. Until then, individual chapters are available electronically here:
http://gestaltrevision.be/en/our-publications/handbook-of-perceptual-organization/accepted-chapters

Other readings of articles and chapters to be assigned.

Format of course:
This will depend on how many people are registered for the course. Assuming the number is small (five or fewer), classes will be held in seminar fashion rather than as lectures with Q&A. I (JRP) will take responsibility for leading the class sessions for the first half of the semester, circulating the readings in advance and organizing the discussions during our class period. For the second half of the semester, individual registered students will take the lead, helping to select the readings and to structure the discussion. In the event the class is a large one, the format will move toward more of a lecture style, but with as much informal, seminar-style interaction as possible. In addition to taking turns as class leaders, students will write a paper due at the end of the term, either a literature review on a topic closely related to perceptual organization or a write-up of an experiment conducted specially for this course during the current semester. Students will be evaluated on the basis of their

end-of-term paper, their assigned leadership of class discussions, and their overall level of class participation.

Brief listing of topics in the approximate order in which they will be examined:
1. Overview: what is perceptual organization?
2. History of the study of perceptual organization
3. The Gestalt Laws & Phenomena: Grouping, Figure-ground, Subjective Contours
4. Further Gestalt Phenomena: Multistability, Coupling, Parts & Wholes
5. Methods I: Phenomenology
6. Methods II: Performance tasks
7. Methods III: Cognitive Neuroscience and neuroimaging
8. Dimensions of Perception: Separable, integral, and configural
9. PO in motion perception
10. PO in scenes, faces, other complex stimuli
11. Theory I: Simplicity vs. Likelihood principles
12. Theory II: Emergent Features and the Theory of Basic Gestalts
13. Organization in other areas of cognition and psychology.

Disability Statement:
Any student with a documented disability needing academic adjustments or accommodations is requested to speak with me during the first two weeks of class. All discussions will remain confidential. Students with disabilities should also contact Disability Support Services in Allen Center.

More detailed description: Studying the organization of perception, like the organization of anything, entails identifying its components and then determining how they are pieced together structurally and how they operate together functionally. The organization of a brick wall involves bricks, mortar, and the particular arrangements used to make the wall. What are the parts of a visual percept? How are those parts arranged and how do they function – interact and change – as ones field of vision changes?

The structure of a visual image may be described in one way by the distribution of light falling on the interior of the eye and focused on the retina. Another description of its structure would be the activation levels of the 130 million rods and cones in the human eye that respond to this light. At the level of conscious experience, however, we remain unaware of individual rod and cone activity; we do not see the "pixels" with which vision begins in the retina, we do not experience the world as a mosaic of colored dots. What parts do we perceive then, and how are those parts combined into wholistic perceptions?

The Structuralists of the late 1800s, led by Titchener at Cornell, believed that the building blocks of perception were primitive sensations, such as the brightnesses of each point in our field of view. Those sensations were claimed to be available to us through introspection, if we tried hard enough to attend to them. Those sensations then simply added up to create percepts. Structuralism dominated cognitive

psychology well into the mid 1900s, and such thinking continues today, albeit in much more sophisticated models that emphasize the feedforward nature of perception. Treisman & Gelade's famous Feature Integration Theory is probably the best-known contemporary example of Structuralism.

Beginning in 1912, the Gestalt psychologists rebelled against the Structuralist view, arguing that the building blocks of percepts were not atomistic points but rather wholes, and that those wholes were different from the sum of their parts. Furthermore, the wholes were argued to be perceived prior to the parts and to dictate what those parts actually were. A simple curved line like "(" can look like the letter C when surrounded by other letters, as in ACE; or like a nose or mouth when placed in the context of a cartoon face such as :) .

Models of pattern recognition today aim to explain how we recognize patterns like squares, triangles, and alphanumeric characters; biological stimuli like animal forms and faces; and complex layouts of surfaces and objects that define entire scenes. If we were to build an artificial perceptual system that could perceive such patterns accurately, we would need to specify exactly how that would work.

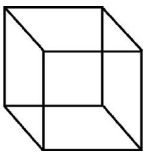
One system for pattern recognition is *template matching*. When a child pushes a square block (cube) through a square hole in a shape board, this ss a form of template matching where spheres and pyramids fit only through their matching holes, the way a lock is opened by just one key. We could recognize faces through a template system, but how plausible is it to think that we have one template for each face we can recognize and have different templates for each angle at which a face can be seen and each expression the face can assume? Quickly we see that we would need an infinite number of templates to recognizes faces, shapes, letters, dogs, and scenes as quickly and accurately as we do.

The main alternative to template matching theory are *feature theories*, whereby we recognize whole patterns by detecting the features they possess. The letter F contains one long vertical, one shorter horizontal at the top and another at the midpoint. By defining these features in relational terms, we could recognize the letter F at any orientation or angle and at any size. The same would be true for recognizing faces by extracting the features of eyes, ears, and noses, and so forth. The challenge would then be to make sure that we had properly identified the correct features and had determined how they were combined or integrated to allow us to recognize the whole pattern.

Thus, the study of perceptual organization is the study of how our percepts are structured. What are the parts, and how are those parts combined to yield complex perceptions that constitute our experience of the world.

Along the way, we will confront the key issues that arise in perceptual organization. One issue is *multistability*, which arises when a stimulus can be perceived in two or more different ways. The Necker Cube is a classic example – it is a line drawing of a

cube that for the perceiver flips back and forth between two very different orientations, even those perceivers know full well the drawing is not changing, only their perception of it is.


Necker Cube

We will also consider the problem of *perceptual coupling*, whereby two or more dimensions of a stimulus are perceived together in an integral fashion. When one looks at a rectangle, for example, one cannot see its height without also seeing its width, suggesting that those two dimensions are perceptually integral. That may be contrasted to the ease with which we can attend to the color of a particular shape, like a circle or a square, while ignoring what the actual shape is, leading us to conclude that color and shape are perceptually separable.

A classic problem in perceptual organization has been *figure-ground segregation*. When we see a tree standing in front of a house, it is clear to us that the house continues behind the tree even in those areas when the tree occludes (blocks our view of) the house. With the portions of the house that we can see between individual patches of leaves, as with the bits of sky we can see looking upward through the canopy of trees, we know that the shape of those patches of house or sky are not part of the house or sky themselves but only the shape of the hole in the leaves through which we see them. When we encounter edges in our field of view, as between a leaf and the sky, we must quickly and correctly determine which side of the edge belongs to the nearer, occluding object, and use that to determine such things as whether any curve in that edge is concave or convex.

We will consider the order in which parts and wholes are perceived. Feedforward models of perception have the parts preceding the wholes, just as the bricks must be formed before a wall can be built from them. There are many examples of configural superiority effects, however, wherein perceivers can recognize wholes before they have recognized any part.

The study of perceptual organization has a long and growing connection to cognitive neuroscience. Nearly 100 years ago, lateral inhibition was first discovered in horseshoe crabs, and it told us how signals from photoreceptors interacted with one another to create a visual system that was highly sensitive to change in space (i.e., edges) and in time (i.e., motion or flicker), far more sensitive to such change than to stimulation that was homogeneous and unchanging. Later, Hubel and Wiesel won the Nobel Prize for discovering cells in the visual system of cats and monkeys that seemed to be organized to recognize the tilts or slopes of edges and lines in the visual field, leading to the hypothesis that oriented edges were the building blocks of shape perception. Today we know far more about what features in the retinal image the cortex attempts to extract, and we are beginning to understand how neurons

might be responsible for Gestalt effects in perception, whereby the perception of parts depends on the context in which those parts appear, and whereby wholes are recognized prior to those parts.

In the study of **memory**, one may ask whether memory for a whole list of words, a whole series of tones, or a sequence of events is simply the sum of the memories of those parts. George Miller famously noted how the magical number of 7 +/- 2 might indicate how many items could be held in memory, but that begs the question of what exactly is an item. As Miller noted, nominal items can "chunk" together into larger items, just like contours can group into larger shapes.

In the field of **attention**, we ask how many things a person can pay attention to at one time, but we are often unable to say exactly what we mean by a "thing." In the field of **motor control**, we ask how many responses or tasks can be carried out simultaneously, such as walking and chewing gum at the same time. Again, however, the question arises of what constitutes a task. If we play a piano with all ten fingers and thumbs, are we performing ten tasks simultaneously?

Perceptual organization has broad relevance to other fields within psychology, including **human factors**. The design of graphical user interfaces is in large part an effort to configure the information in a display so that this information forms useful groups or chunks of information. A major principle of Gestalt grouping is common region, wherein elements that are contained within a boundary contour as seen as belonging together. This idea is what underlies the concept of a window in a computer display. In a different arena, perceptual organization research has guided the development of camouflage by identifying the methods by which a figure can be made to blend in with it background. Wayfinding is still another area where perceptual organization helps to make maps clear and to make pointers more effective. Similar extensions of perceptual organization into areas like architecture, visual art, and music can be considered if there is sufficient interest.

Tentative sequence of topics and readings (first two weeks only at this time):

1. Overview: what is perceptual organization?
    - Pomerantz, J. R., & Kubovy, M. (1981). Perceptual organization: An overview. In M. Kubovy, & J. R. Pomerantz (Eds.), Perceptual Organization (pp. 423-456). Hillsdale, NJ: Lawrence Erlbaum Associates.
    - Kuhlmann, M. (2013). What is real? Scientific American, August 2013, 40–47.

2. History of the study of perceptual organization
    - Wagemans, J., Elder, J. H., Kubovy, M., Palmer, S. E., Peterson, M. A., Singh, M., and von der Heydt, R (2012a). 'A century of Gestalt psychology in visual perception I: Perceptual grouping and figure-Ground organization'. Psychological Bulletin 138 (6): 1172–217.
    - Wagemans, J., Feldman, J., Gepshtein, S., Kimchi, R. Pomerantz, J. R., van der Helm, P., and van Leeuwen (2012b). 'A century of Gestalt psychology in visual perception II: Conceptual and theoretical foundations'. Psychological Bulletin 138 (6): 1218–52.

3. The Gestalt Laws and Key Phenomena: Grouping, Figure-ground
    - Readings from Handbook of Perceptual Organization

4. Further Gestalt Phenomena: Multistability, Coupling, Parts & Wholes

- Readings from Handbook of Perceptual Organization

5. Methods I: Phenomenology

- Kanizsa G. (1979). Organization in Vision: Essays on Gestalt Perception. (New York: Praeger Publishers).
- Albertazzi, A. (2013). Philosophical background: Phenomenology. In J. Wagemans (Ed.), Oxford Handbook of Perceptual Organization (in press). Oxford , U.K.: Oxford University Press.
- Koenderink, J. (2013). Methodological background: Experimental phenomenology. In J. Wagemans (Ed.), *Oxford Handbook of Perceptual Organization* (in press). Oxford , U.K.: Oxford University Press.